Space Weather Technical Forecast

Issued on Sunday 8 December 2024 at 13:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares and a Slight chance of Solar Radiation storms and isolated X-class Flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High activity was observed at GOES16, peaking at a X2.2 flare at 08/0906 UTC from AR3912 in the southwest. This was preceded with earlier M-class flares from AR3917 and an M3.2 from AR3910 in the northwest at 07/2215UTC.

There are now up to nine regions on the disc, including a new bipolar region in the far northeast. AR3917 appears to be the most magnetically complex showing signs of development in the intermediate spots, and possibly the most likely to produce M-class flares. Given sunspot AR3912's recent X-class flare, the risk of it producing another remains, with the region expected to remain on the earth-facing disc until early Day 3 (10 Dec). A newly numbered region to the south of AR2917 has continued to develop while several other newly numbered regions have appeared on the disc, mainly as Axx groups and are generally simple and unmagnetically complex.

Following on from the X2.2 flare from AR3912 at 08/0906 UTC analysis is currently on-going, pending results for any Earth-directed CME's. Early indications hint that we may see an enhancement to the geomagnetic activity from early on Day 3 (10 Dec) but this is subject to further analysis.

Solar Wind / Geomagnetic Activity: Solar winds, as recorded at L1 by ACE, remain Slow-ambient with speeds 350-390km/s. Density was above average yesterday afternoon UTC but appears to have dropped to average at present. Perhaps indicating a connection to CH98+. The IMF (Bt) has been largely Moderate with a peak at 10nT trending to weak within the last few hours. The north-south component fluctuated for the first half of the period between +3 and -1nT before favouring negative (south) conditions around -7 to -2nT from midnight UTC. The phi angle began negative (towards the Sun), but underwent a lasting transition into a positive (away from the sun) sector after 07/1800UTC.

Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels.

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High energy electron flux (greater than 2MeV) observed by GOES16 was at largely Normal Background levels.

The associated 24-hour fluence was below Active, and the 08/0000 UTC observation was 1.73e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Chance of isolated M-class flares, and a Slight Chance of isolated X-class flares, with no significant sunspot region departures, but perhaps one imminent significant returning region.

Solar Wind / Geomagnetic Activity: Initially slow solar winds may give way to the fast wind from CH98/+ during day 1 (08 Dec), although any effect is likely to be muted given our proximity to the solstice. Initial evaluation of a CME associated with the X2.2 flare looks to potentially see some Earth-directed impacts from early Day 3 (10 Dec) but further analysis is needed.

Quiet to Unsettled geomagnetic conditions are expected with perhaps a Slight Chance of Active throughout, potentially increasing from Day 3 onwards.

Energetic Particles / Solar Radiation: There is a Slight Chance that the recent X2.2 may produce an S1-scale enhancement, giving a modest rise in the risk within Day 1 (08 Dec), slowly returning to background levels through Day 2 (09 Dec).

High energy electron flux is expected to start within Normal Background levels, perhaps rising in the wake of the fast wind from CH98/+ but the 24-hour fluence is currently not envisaged approaching the Active threshold.

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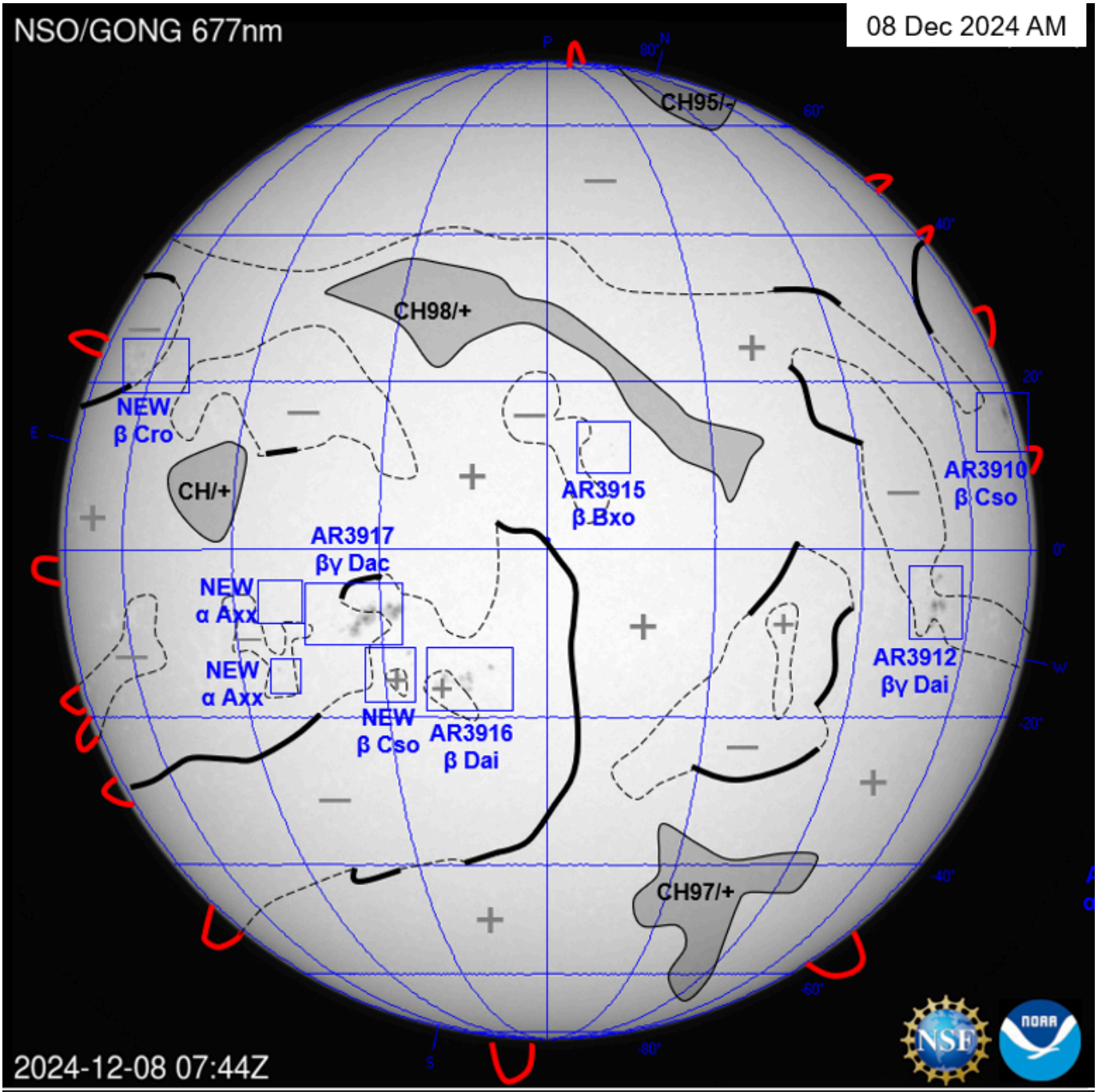
Figure 1: Solar Synoptic Map valid 08/0744 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Following on from the X2.2 flare at 08/0906 UTC analysis is currently on-going, pending results for any Earth-directed CMEs.

An earlier than expected connection to the fast wind from CH98+ appears to have taken place, which is consistent with MOSWOC Enlil output, showing winds increasing through Day 1 (08 Dec). Current solar wind speeds are generally around 350-390km/s with winds not expected to increase much more than 400km/s based of the previous rotation of CH98+. Despite this connection to the HSS, geomagnetic activity is still expected to be subdued given the time of year (near the semi-annual minimum geoeffectivity of coronal holes of any polarity around the solstices).

As a result, Quiet to Unsettled geomagnetic conditions are expected with perhaps a Slight Chance of Active if the Bz stays predominantly negative. Early indications hint that the CME that left the Sun earlier this morning UTC, may see an enhancement to the geomagnetic activity from early on Day 3 (10 Dec) but this is subject to further analysis.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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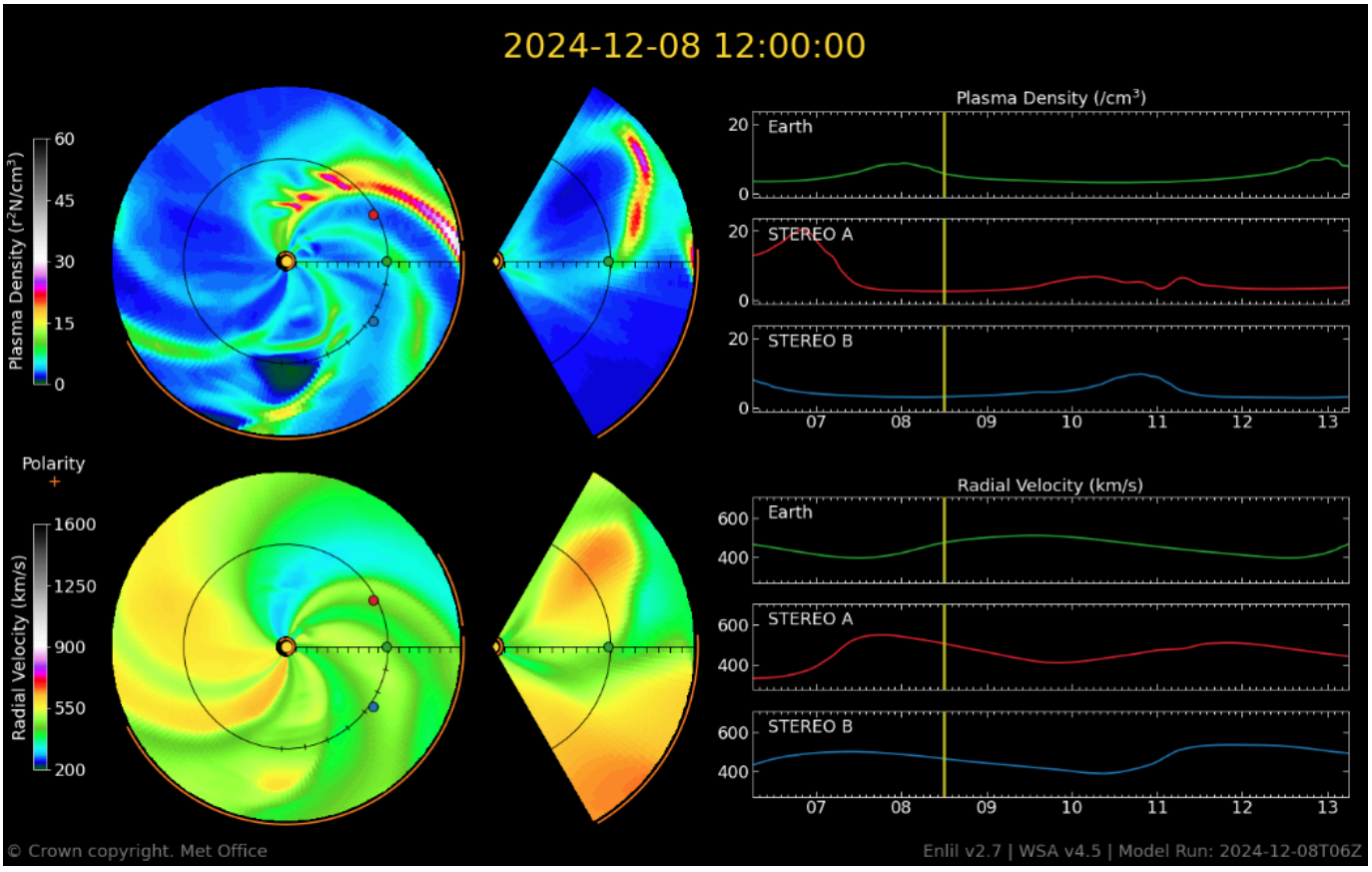
Figure 2: MOSWOC Enlil output



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Radio Blackouts - X-Ray Flares

There are now up to nine regions on the disc, including a new bipolar region in the far northeast, currently difficult to analyse due to its location but this should become easier as it rotates around. AR3917 appears to be the most magnetically complex showing signs of development in the intermediate spots, and possibly the most likely to produce M-class flares. AR3916 also remains magnetically complex but largely staying the same since the last issue. Given sunspot AR3912's recent X-class flare, the risk of it producing another remains, with the region expected to remain on the earth-facing disc until early Day 3 (10 Dec). A newly numbered region to the south of AR2917 has continued to develop while several other newly numbered regions have appeared on the disc, mainly as Axx groups and are generally simple and unmagnetically complex.

Regarding the balance of front-sided regions, no significant regions are due to depart the disc, however returning region Ex-AR3893 is due over the southeastern solar horizon inside the next 24 hours - this group produced M-class flares on its last pass.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	50	50	50	50
Very Active	R3-R5 (X Class)	Yes	10	10	10	5

Figure 3: X-ray flare trace from GOES16 & 18 showing the peak X2.2 flare at 08/0906 UTC

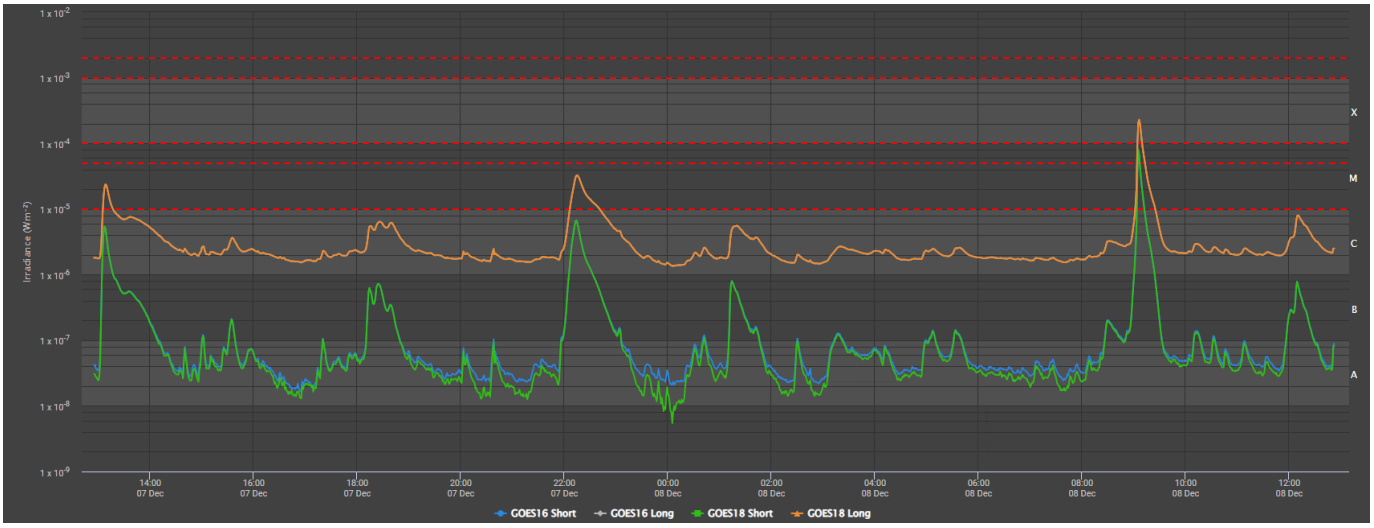

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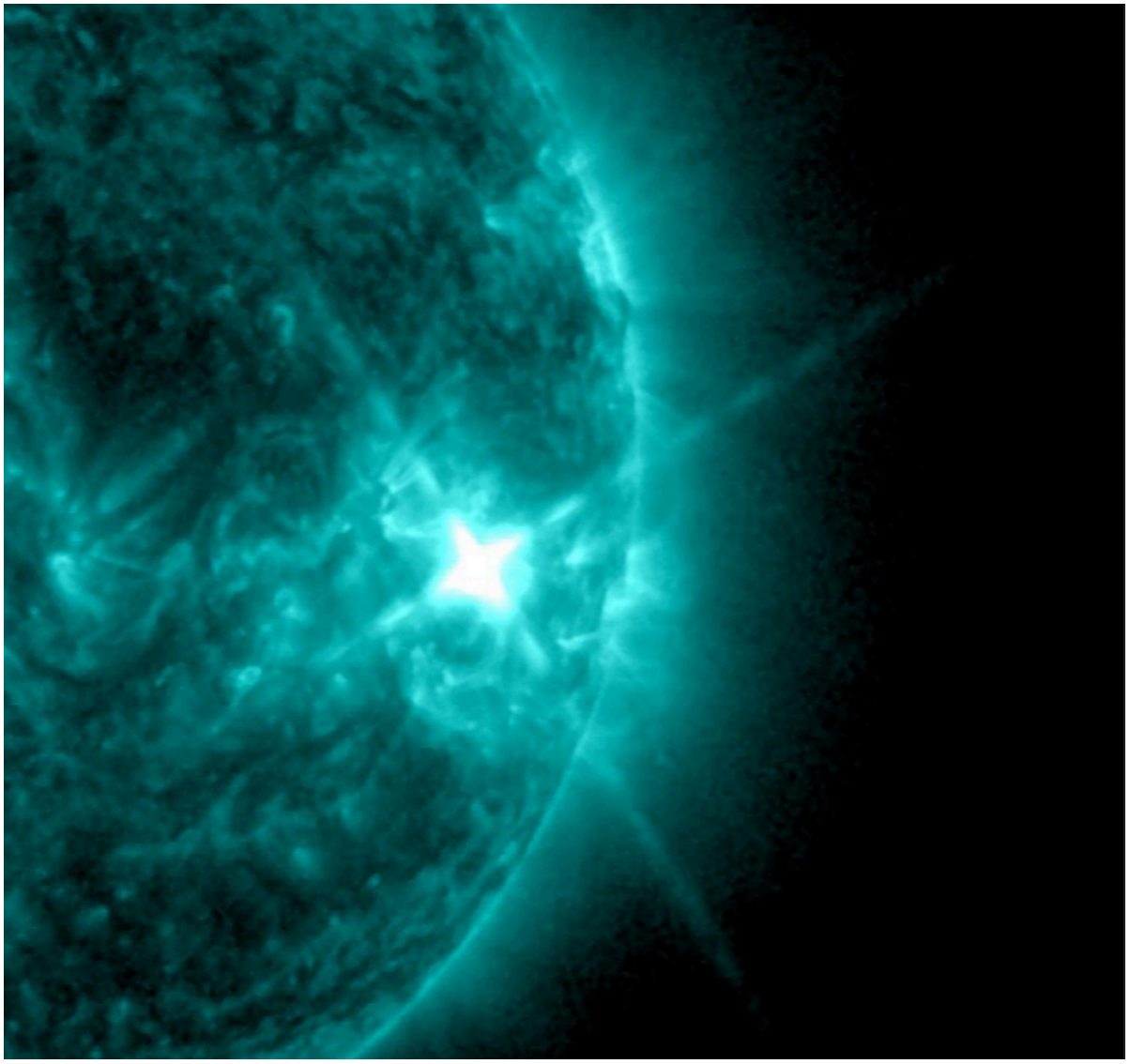
Figure 4: X2.2 Solar Flare visible in GOES16 SUVI imagery.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is currently at Background levels, however there is a Slight Chance that the recent X2.2 may produce an S1-scale enhancement, giving a modest rise in the risk within day one (08 Dec), slowly returning to background levels through Day 2 (09 Dec). Many of the sunspot regions on the Earth-facing disc currently small and relatively simple, and the potentially generative more complex regions are further east.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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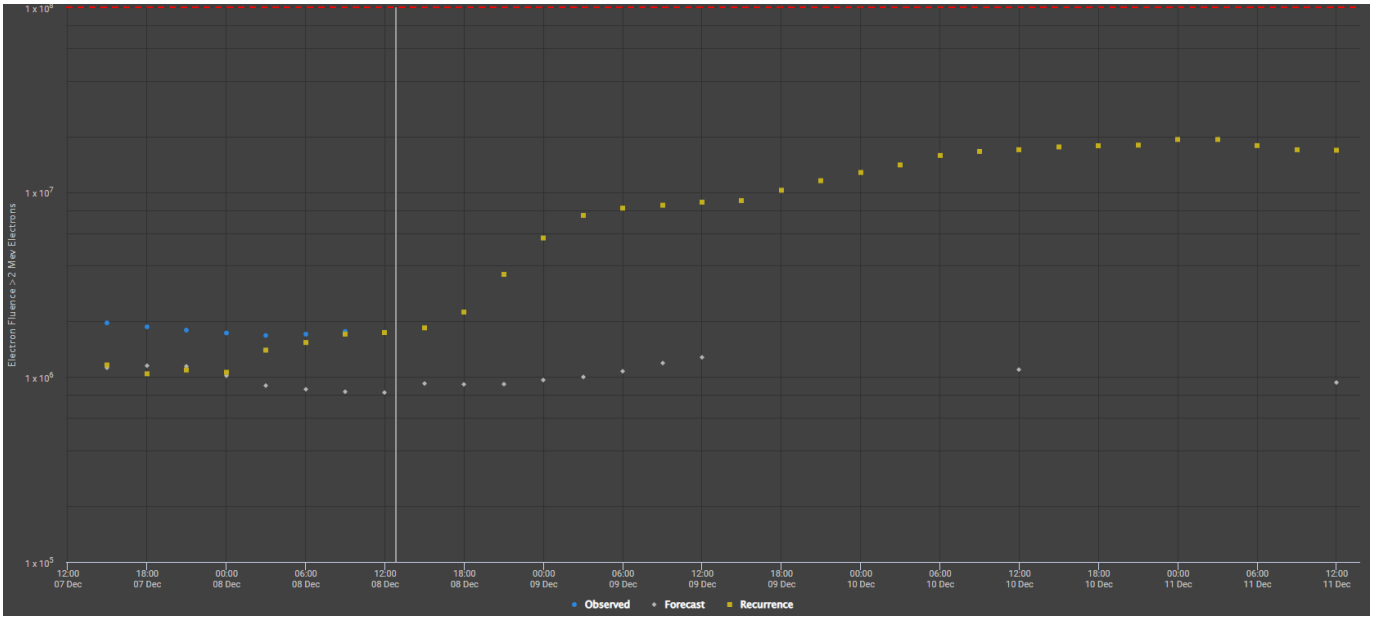
High Energy Electrons (≥ 2MeV)

High energy Electron flux observed by GOES16 has been at Normal Background levels. However, with the potential that a connection to a high speed stream from CH98+ has arrived earlier than anticipated, electron flux may increase through the coming days, with diurnal peaks up to Moderate levels from Day 1 (08 Dec).

The associated 24-hour fluence is expected to remain below Active levels, although a slight increase may occur into the start of the week UTC. With MOSWOC REFM considered reasonable guidance showing a slight increase in coming days but overall keeping the fluence below the Active threshold.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	5	10	10	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Figure 5: Latest MOSWOC REFM output.



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